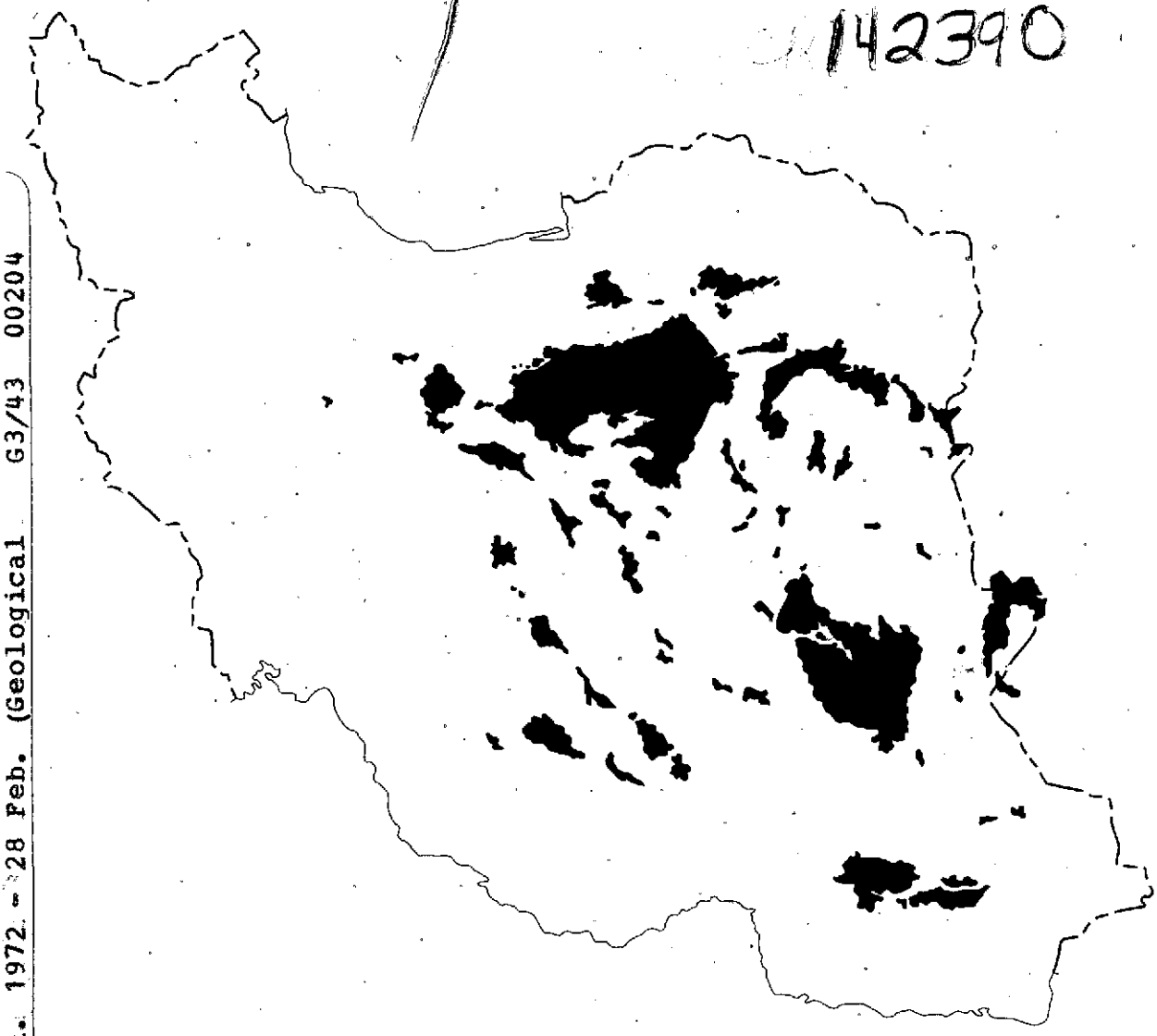
THE UTILIZATION OF ERTS – 1 GENERATED IMAGES IN THE EVALUATION OF SOME IRANIAN PLAYAS AS SITES FOR ECONOMIC AND ENGINEERING DEVELOPMENT

By

Daniel B. Krinsley



Part II

U.S. Geological Survey
Reston, Virginia 22092

Final Report—Contract S-70243-AG, MMC # 195A
Task (30) 434-641-14-03-32
Prepared For—NASA/Goddard Space Flight Center
Greenbelt, Maryland 20771

JUNE 1974

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle
THE UTILIZATION OF ERTS-1 GENERATED IMAGES IN THE EVALUATION OF SOME IRANIAN PLAYAS AS SITES FOR ECONOMIC AND ENGINEERING DEVELOPMENT Pt.II (SR 195)

5. Report Date
30 April 1974

6. Performing Organization Code

7. Author(s)
Daniel B. Krinsley (IN 037)

8. Performing Organization Report No.

9. Performing Organization Name and Address
Geological Survey
National Center (908)
12201 Sunrise Valley Drive
Reston, Virginia 22092

10. Work Unit No.

11. Contract or Grant No.
S-70243-AG-3

13. Type of Report and Period Covered
Type III Final Report
1 July 72 - 28 February 74

12. Sponsoring Agency Name and Address
Mr. Fred Gordon
Goddard Space Flight Center
Greenbelt, Maryland 20771

14. Sponsoring Agency Code

15. Supplementary Notes
Returned from Patent Ct. 1/16/75 SC

16. Abstract

The repetitive coverage of ERTS-1 was used to provide sequential scenes of the Iranian Playas from which hydrologic and morphologic changes were monitored and their economic and engineering significance evaluated, especially on the basis of prior ground control.

At their 1973 maxima, the lakes at Qom and Neriz Playas contained 400×10^6 m^3 and 794×10^6 m^3 of water, respectively. This water, crucial to any agricultural or industrial expansion in these moderately populated areas, should be stored prior to its arrival in the shallow playa lakes where it is annually lost by evaporation.

The Great Kavir in north-central Iran is a vast desert with extensive salt crusts and swamps. During the period of maximum inundation and lowest bearing strengths, as inferred from the image of May 12, 1973, a preliminary road alinement was selected across the Great Kavir. This route avoided the wettest or roughest areas, took advantage of the best terrain, and reduced the road distance between northern and central Iran by as much as 700 km, and the travel time by as much as 10 hours.

Color reproductions of illustrations EDC-010008 to EDC-010022 are available for purchase from the EROS Data Center.

17. Key Words Suggested by Author	18. Distribution Statement
Playa Iran Playa lakes Playa roads	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Not applicable	Pt.II 53	

Figure 2A. Technical Report Standard Title Page. This page provides the data elements required by DoD Form DD-1473, HEW Form OE-6000 (ERIC), and similar forms.

03

III

THE UTILIZATION OF ERTS-1 GENERATED IMAGES IN THE EVALUATION OF SOME IRANIAN PLAYAS AS SITES FOR ECONOMIC AND ENGINEERING DEVELOPMENT

Daniel B. Krinsley
Geological Survey
National Center (908)
12201 Sunrise Valley Drive
Reston, Virginia 22092

30 April 1974

Type III Final Report for Period 1 July 1972 - 28 February 1974

Prepared for:

Goddard Space Flight Center
Greenbelt, Maryland 20771

1195A

PART II

ILLUSTRATIONS

FIGURES

FIGURES--Continued

TABLES

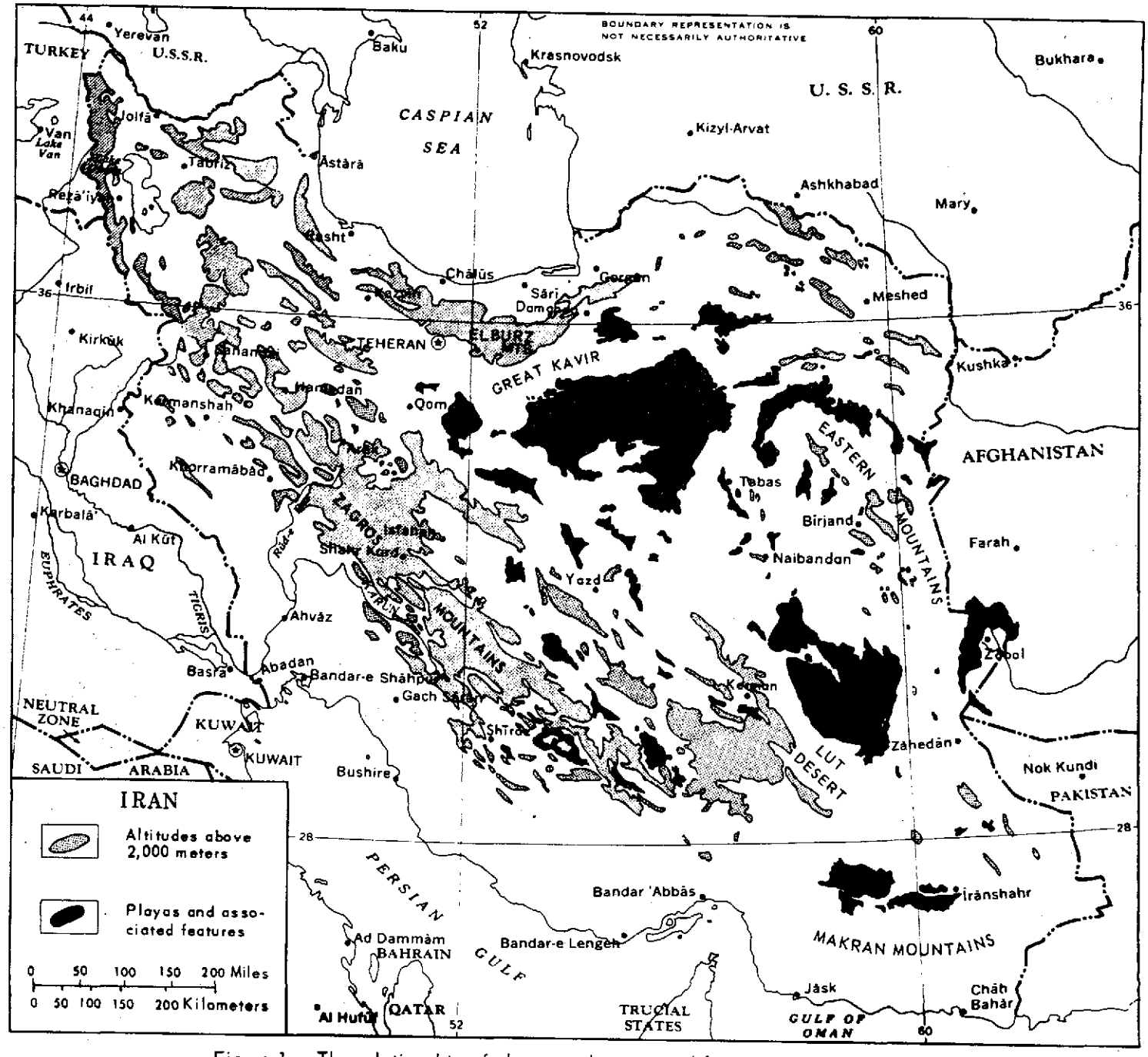


Figure 1 – The relationship of playas and associated features to relief in Iran.

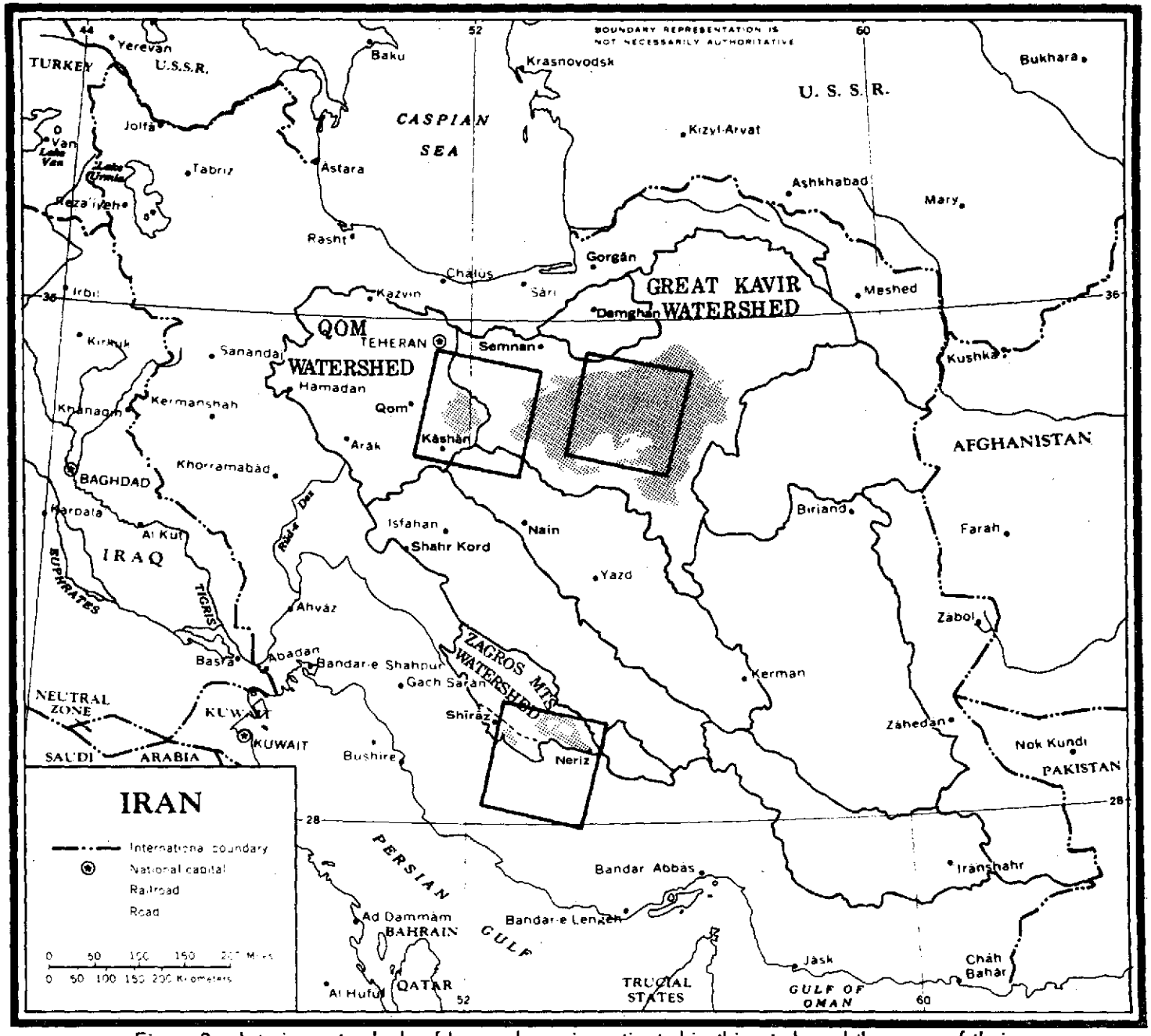
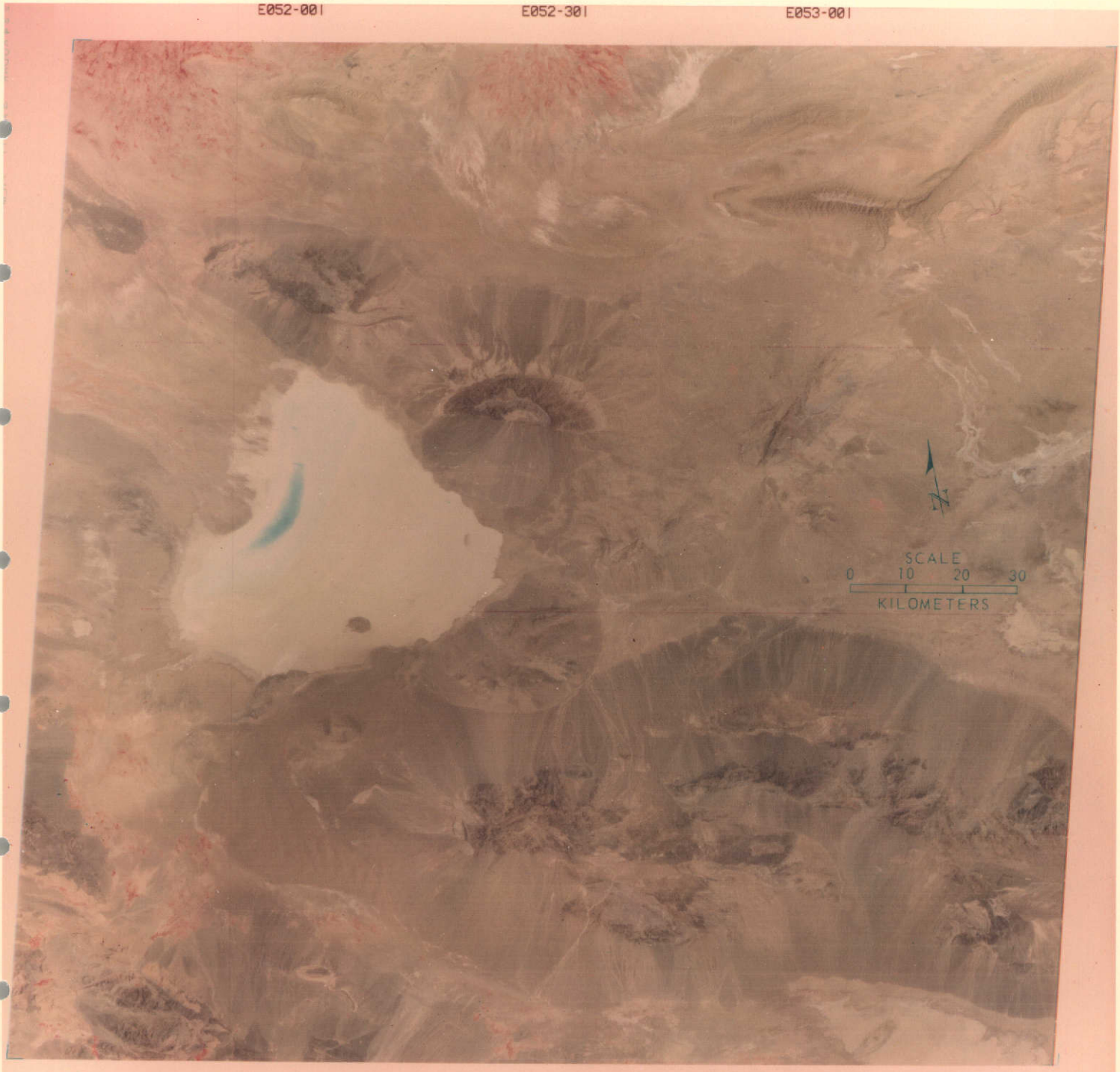


Figure 2 – Interior watersheds of Iran: playas investigated in this study and the areas of their ERTS-I images.

Figure 3 – Qom Playa, September 4, 1972; false-color composite of ERTS-I image. EDC-010008.

E052-001 E052-301 E053-001



E051-301 E052-001 E052-301

04SEP72 C N34-29/E052-17 N N34-27/E052-21 MSS 4 5 7 R SUN EL52 AZ130 190-0593-A-1-N-D-2L NASA ERTS E-1043-06382-5 01

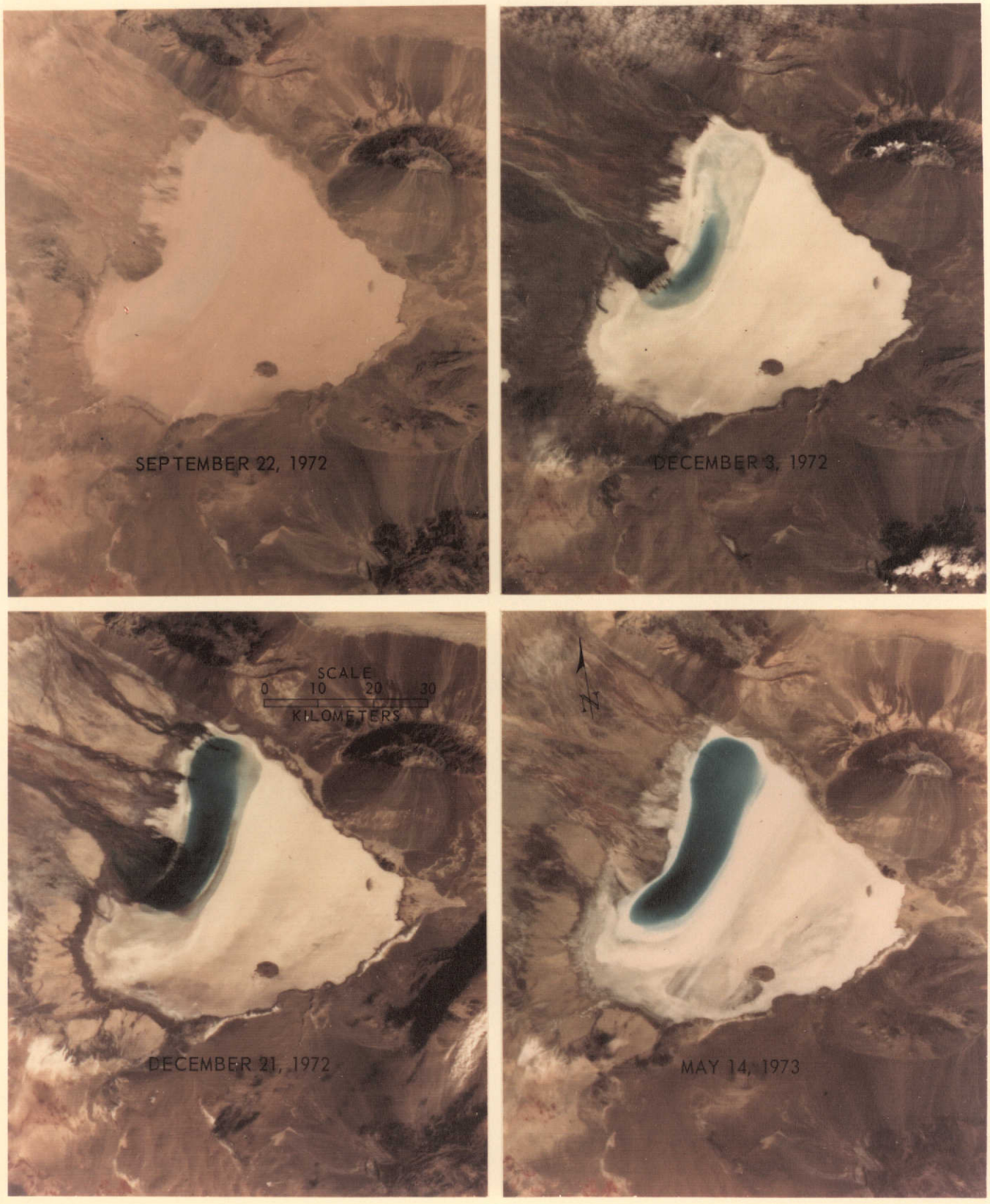
Figure 4 – The boundary in Qom Playa between the wet muddy area overlain by a thin veneer of salt in the background, and the thick salt crust with raised-ridge polygons in the foreground. The view is northwest from the west center of the playa and from an altitude of 200 m; date August 29, 1967.

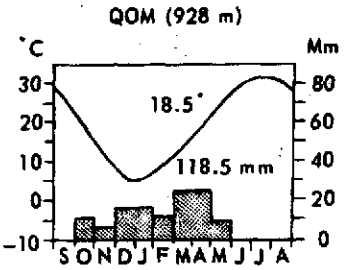
Figure 5 – Raised-ridge polygons in the salt crust east of Sargardani Island in Qom Playa. The dark colored ridges are composed of admixed salt, clay and silt which has been extruded upward through the cracks between the polygonal plates by the expansion of the muddy brine during the heat of midday. The polygons are approximately 1 m across; date August 28, 1967.

Figure 6 – The single, pebble gravel beach along the east shore of Sargardani Island, 1.2 m above the salt crust. The slope of the fan on which the helicopter rests is 2°; and, the slope of the beach to the right is less than 1.0°. View is north; date August 28, 1967.

Figure 7 – Lake expansion at Qom Playa, September 22, December 3 and 21, 1972, and May 14, 1973; false-color composites of ERTS-1 images. EDC-010009.

LAKE EXPANSION AT QOM PLAYA 1972-1973





Mean monthly temperature and precipitation; mean annual temperature, total annual precipitation, and altitude of the station at Qom.

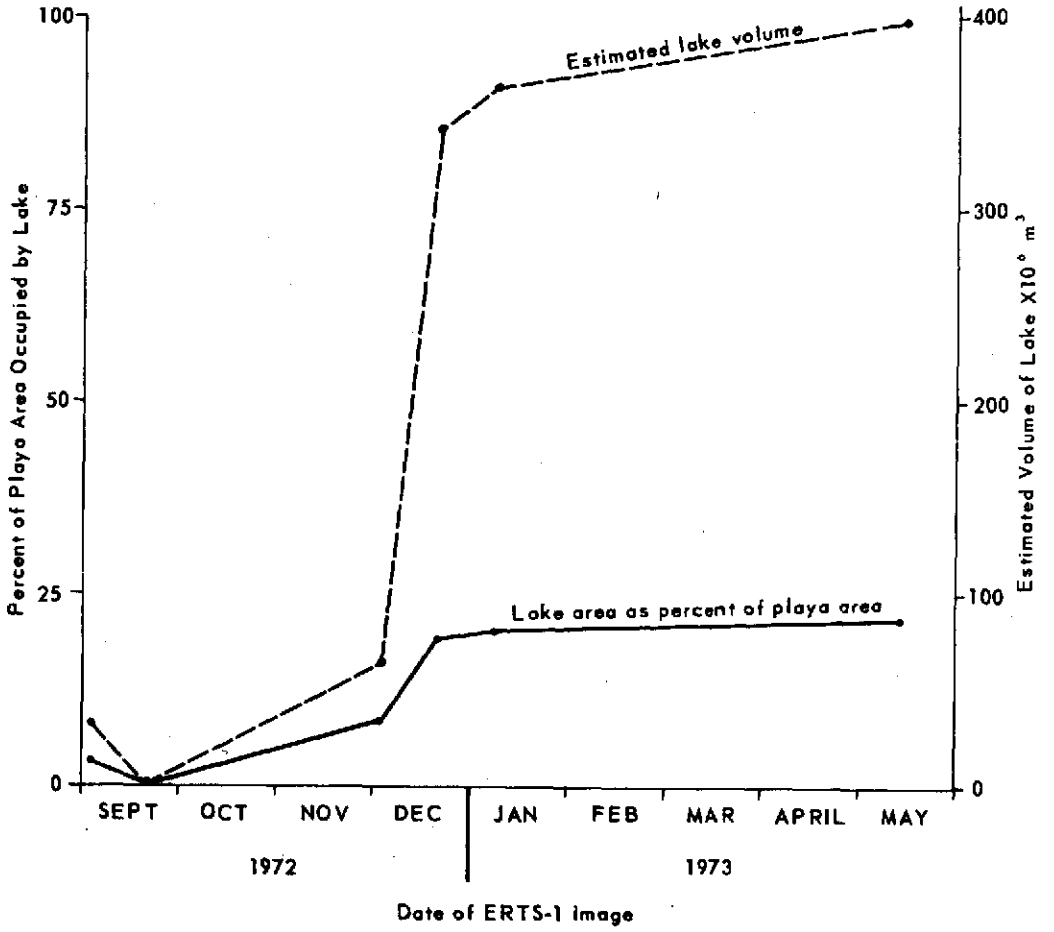


Figure 8 – A comparison of the climatic data from Qom with the lake area at Qom Playa as a percent of the playa area, and the estimated lake volume from September 4, 1972 to May 14, 1973.

Figure 9 – Components of the composite map of the extent of the lake at Qom Playa on December 3 and 21, 1972 and May 14, 1973. EDC-010010.

COMPOSITE MAP
LAKE EXPANSION AT QOM PLAYA 1972-1973

A

SCALE
0 10 20 30
KILOMETERS

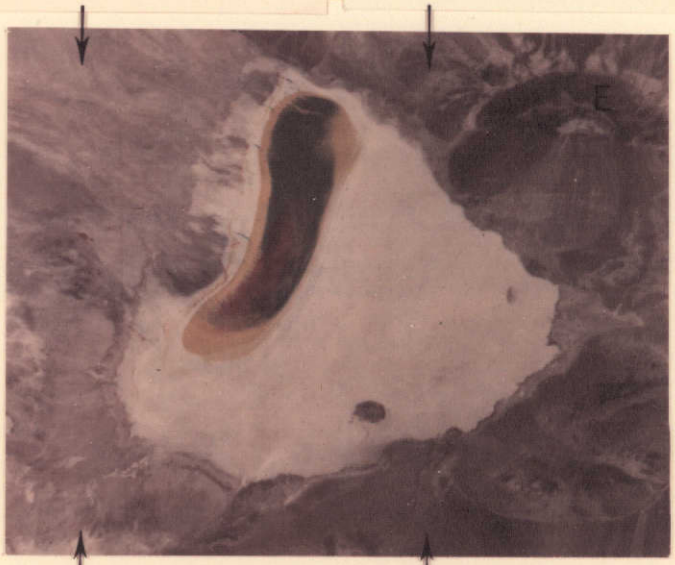
N

B

DECEMBER 3, 1972

DECEMBER 21, 1972

Scenes A, B and C are false-color prints of film positives made from sandwiches of each scene's band 7 negative and band 4 positive.



Scene E is a composite of scenes A, B and C superposed on scene D, which is a false-color print made from positives of band 5 (red) and band 7 (blue).

C

D

MAY 14, 1973

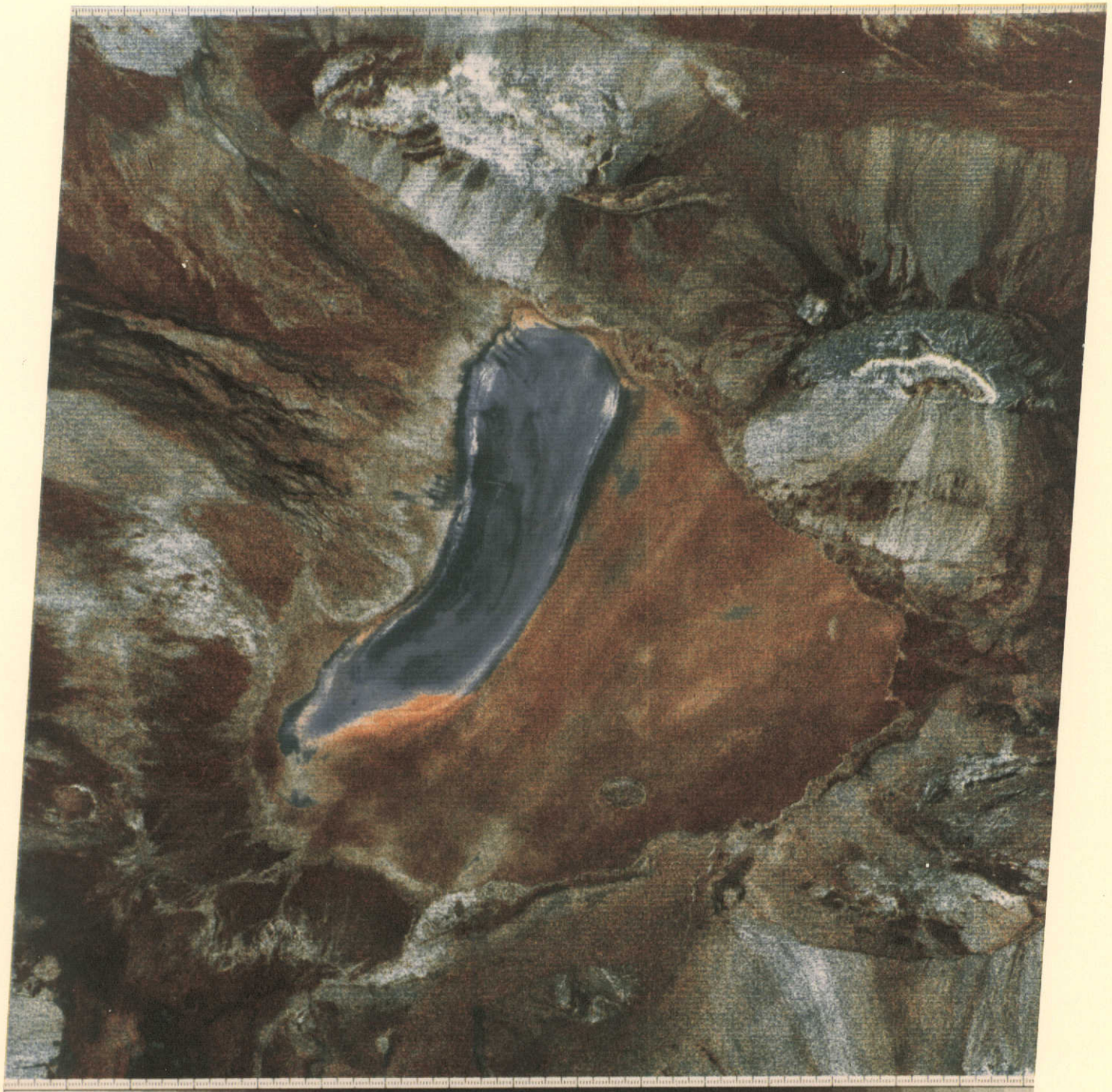
SEPTEMBER 22, 1972

Figure 10 – Computer enhanced false-color composite of Qom Playa, September 22, 1972; band ratios 5/6 blue, 5/7 red. EDC-010011.

SCALE
0 10
KILOMETERS

N

Figure 11 – Computer enhanced false-color composite of Qom Playa, September 22, 1972; band ratios 5/6, 4/5, 4/6 and 5/7. EDC-010012.



1061-06381-L-5 RED 22SEP72 ZAGROS MOUNTAINS PLAYA
C N34-32/E052-20 S N34-30/E052-25 HDG 190 SUN EL47 AZ138 0844
STRETCH
GRN/RED GRN/IR1 RED/IR1 RED/IR2

SCALE
0 10
KILOMETERS

N

Figure 12 – Computer enhanced false-color composite of Qom Playa, September 22, 1972; band ratios 4/6, 5/7, 5/6 and 4/7. EDC-010013.

1061-06381-L-5 GRN 22SEP72 ZAGROS MOUNTAINS PLAYA
C N34-32/E052-20 S N34-30/E052-25 HDG 190 SUN EL47 AZ138 0844
STRETCH
GRN/IR1 GRN/IR2 RED/IR1 RED/IR2

SCALE
0 10
KILOMETERS

N

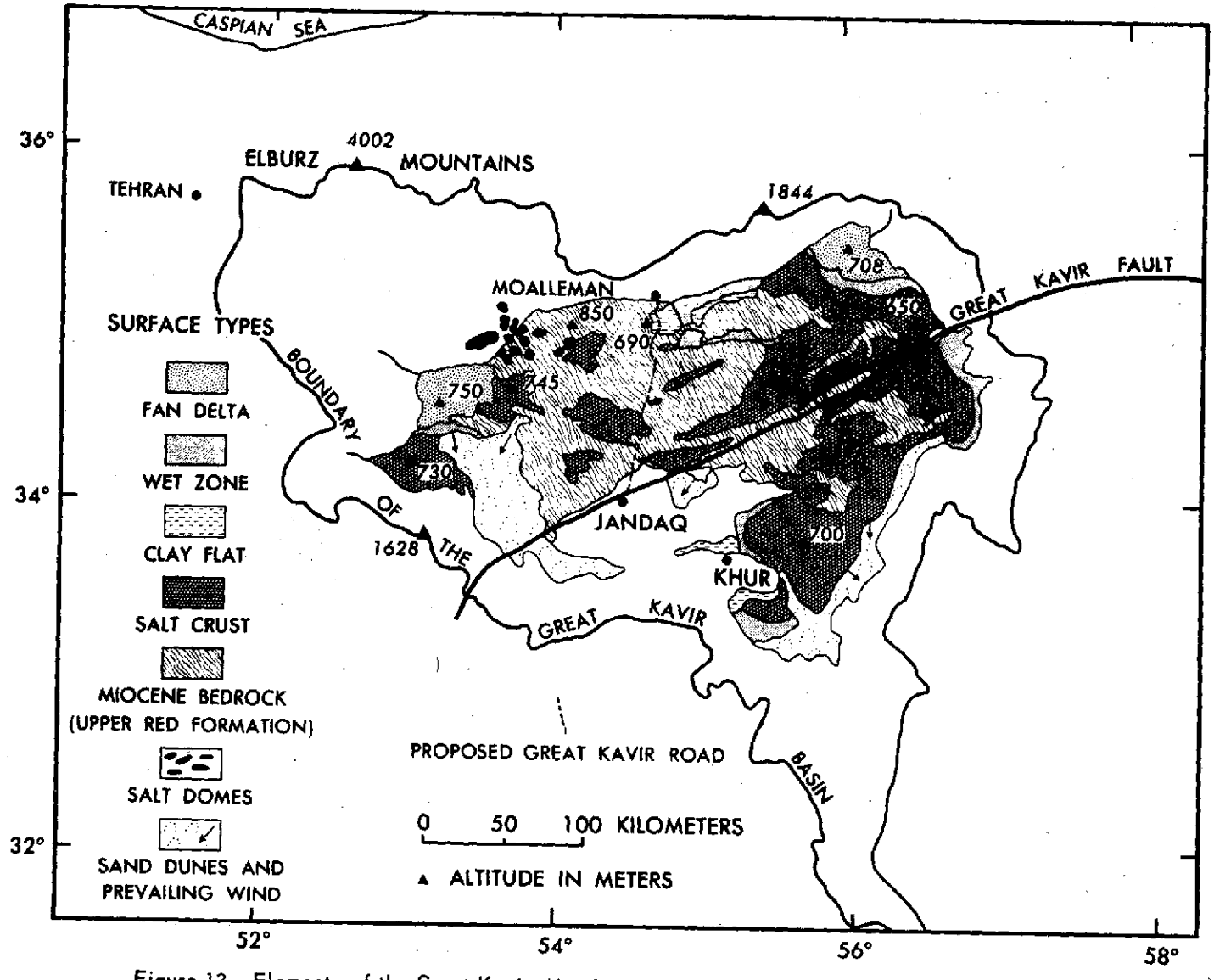


Figure 13 – Elements of the Great Kavir. Map based on author's fieldwork and photointerpretation and on the Geological Map of Iran (National Iranian Oil Company, 1959).

Figure 14 – Rough black salt ridges and pinnacles adjacent to the dry-season road across the Great Kavir, 40 km south of Moalleman. Local relief ranges from 30 to 50 cm; view northwest, date September 2, 1966.

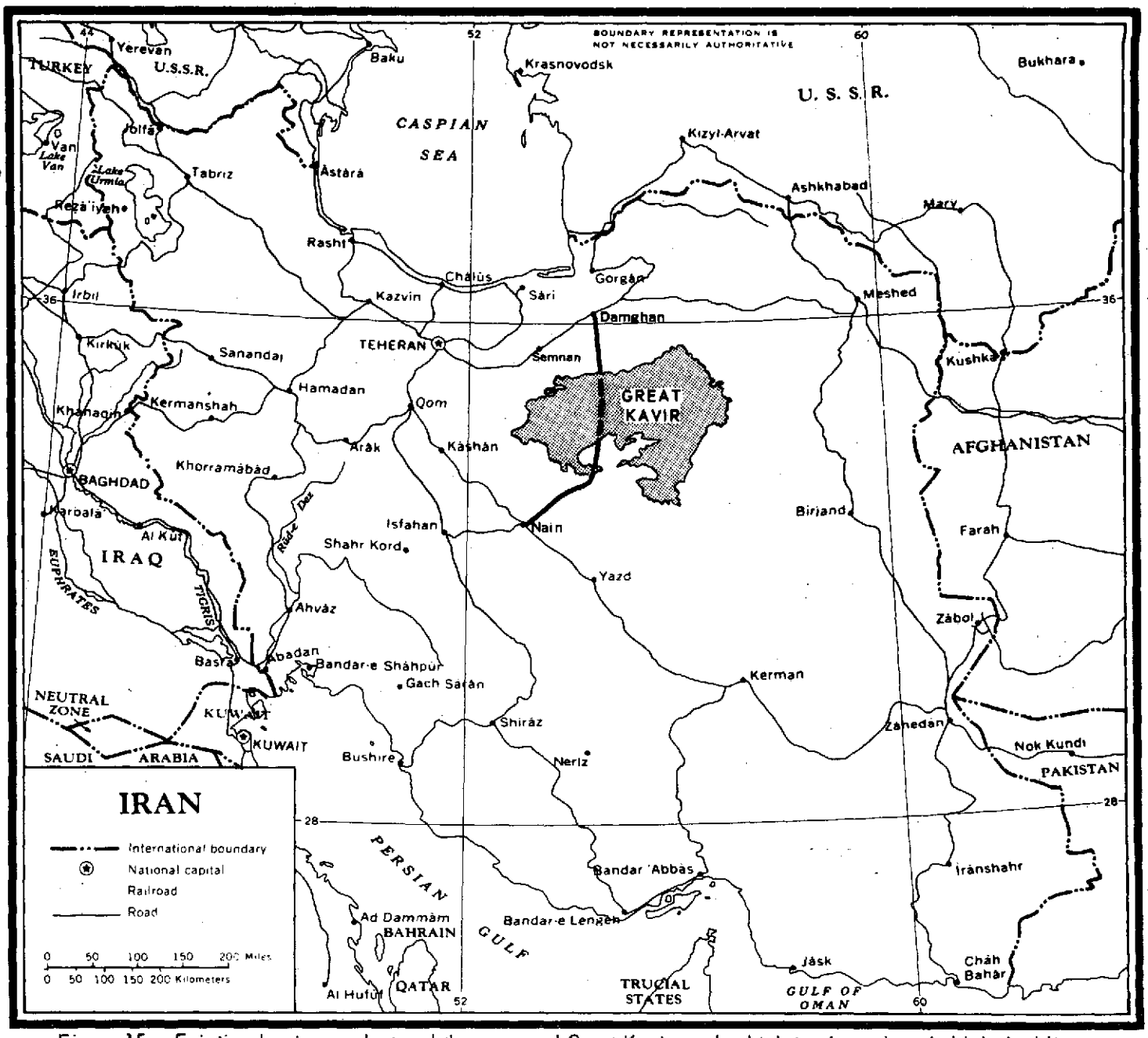


Figure 15 – Existing Iranian roadnet and the proposed Great Kavir road, which is shown by a bold dashed line. The north and south extensions of the proposed road are shown by solid bold lines.

Figure 16 – Great Kavir September 2, 1972; false-color composite of ERTS-I image. EDC-010014.

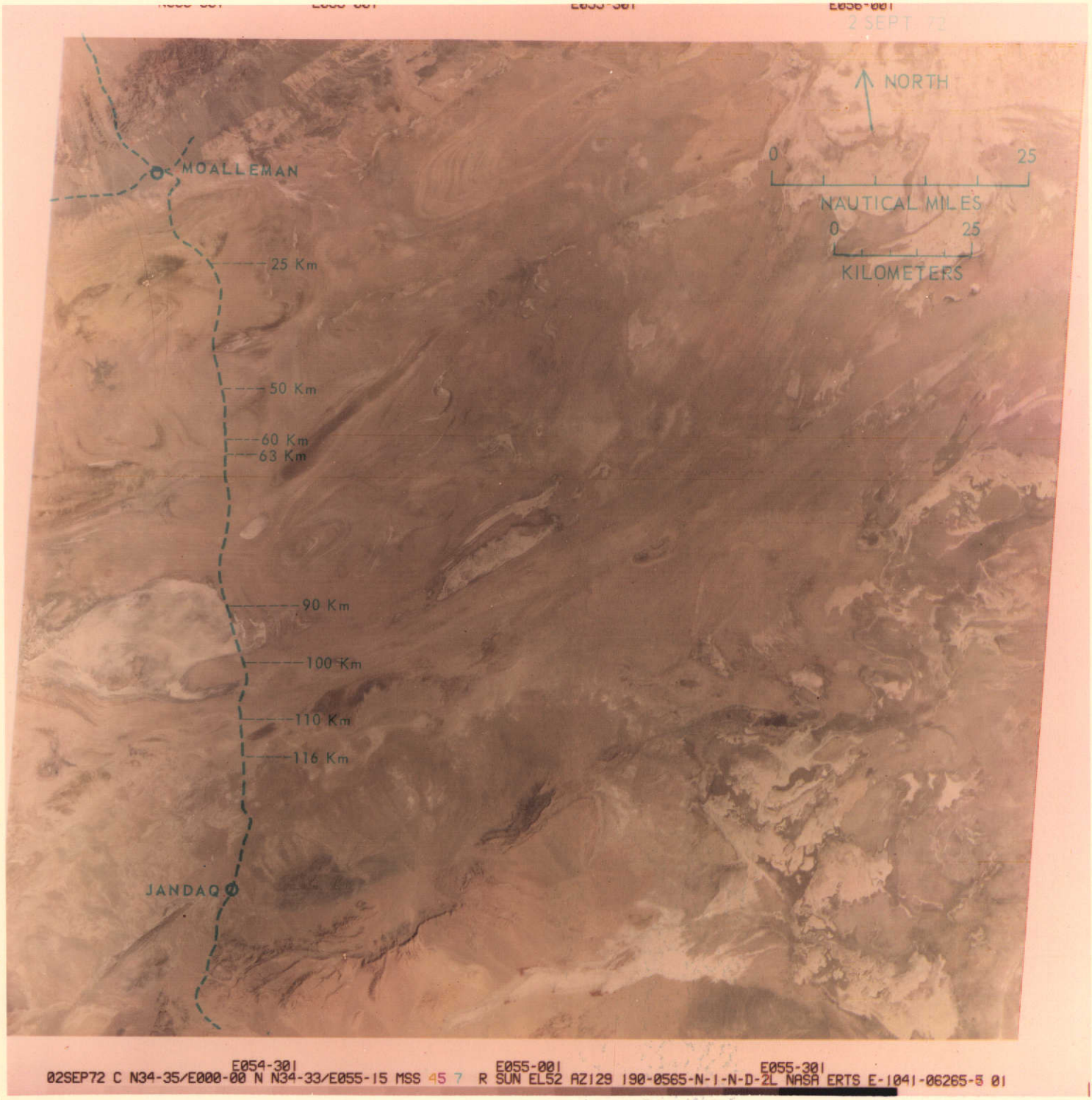


Figure 17 – Great Kavir, September 20, 1972; false-color composite of ERTS-1 image. EDC-010015.

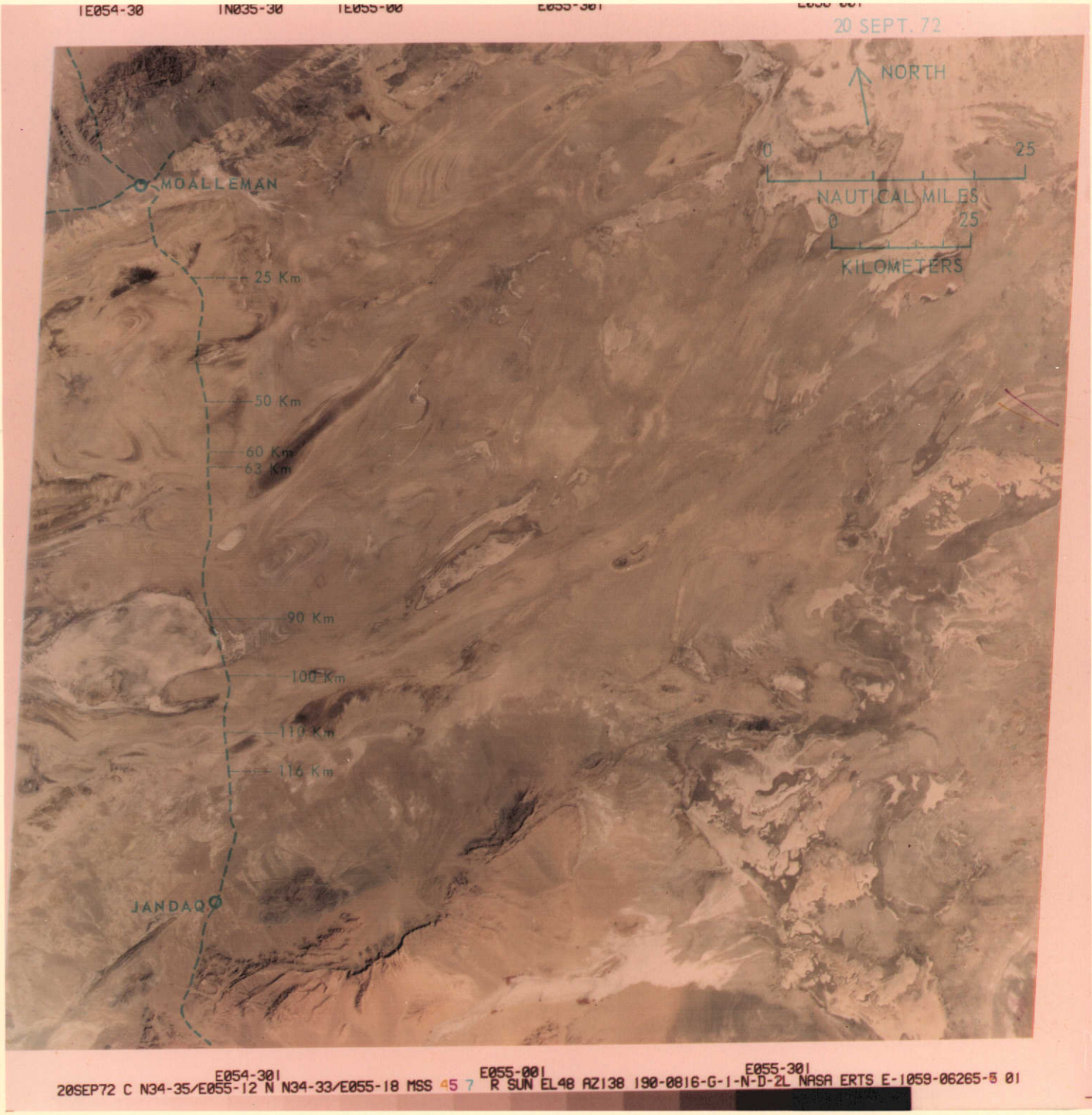


Figure 18 – Great Kavir, December 19, 1972; false-color composite of ERTS-1 image. EDC-010016.

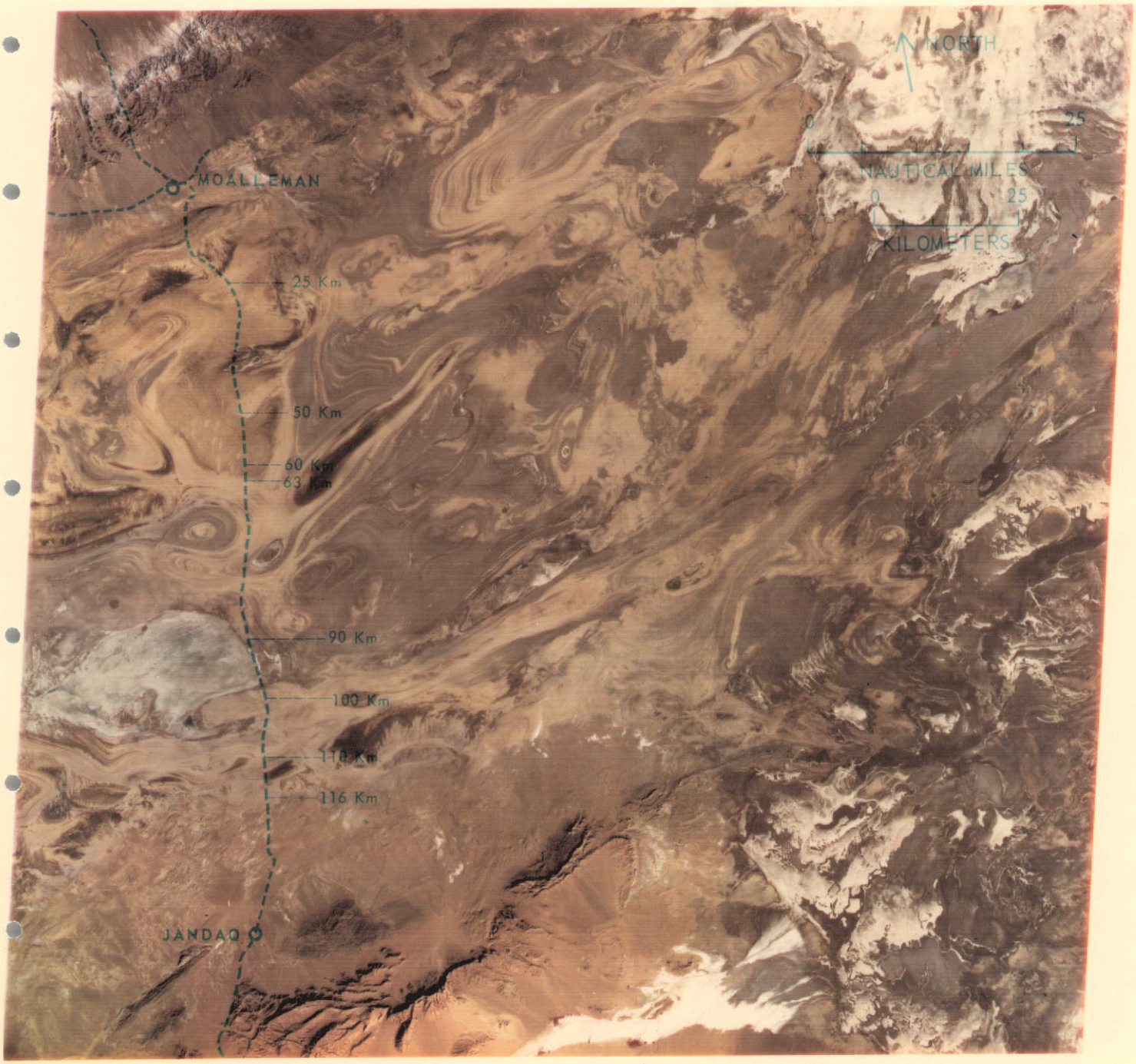
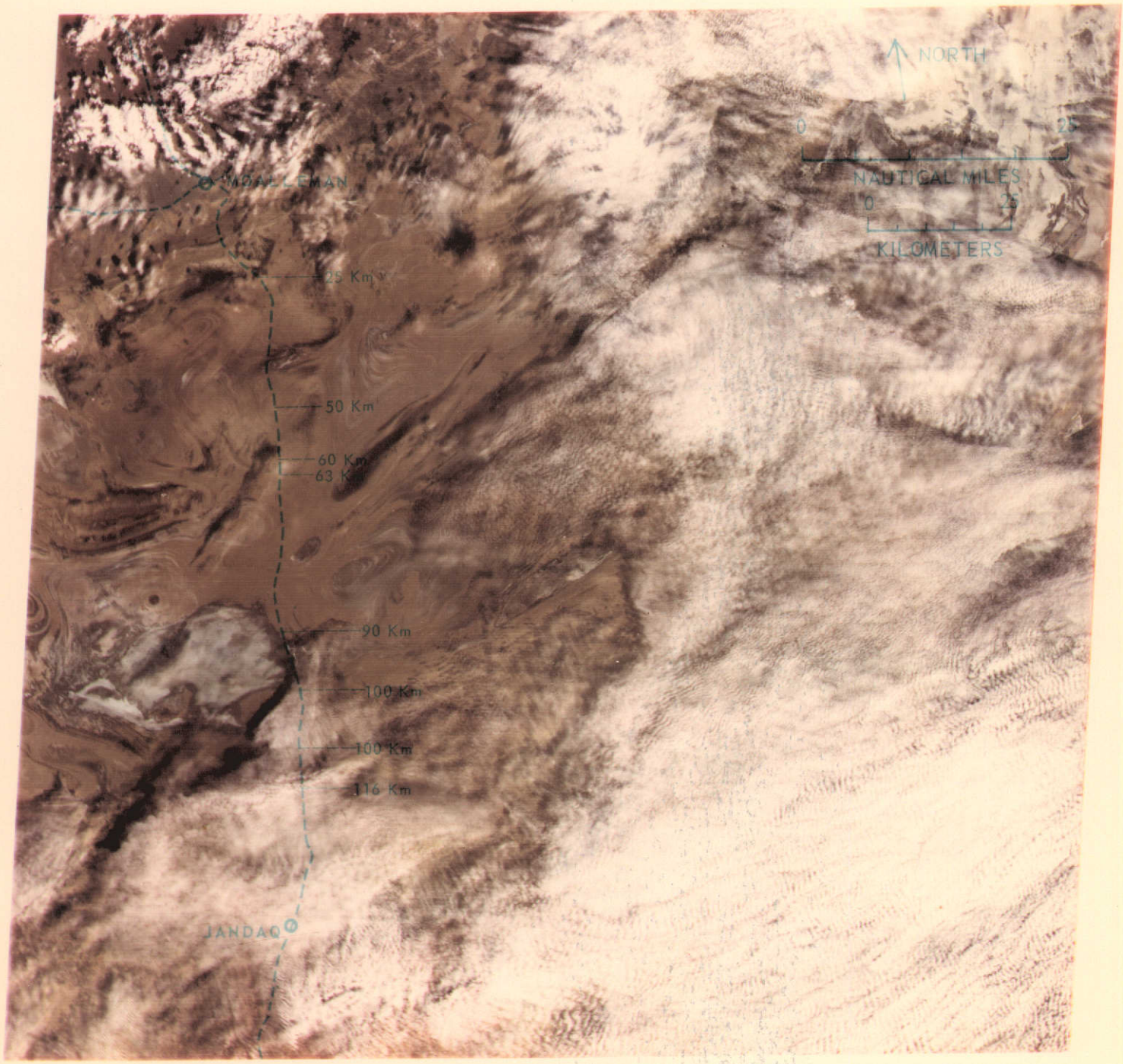


Figure 19 – Great Kavir, February 11, 1973; false-color composite of ERTS-1 image. EDC-010017.



E054-301 E055-001 E055-301
11FEB73 C N34-35/E055-05 N N34-33/E055-10 MSS 45 R SUN EL32 AZ142 190-2824-G-1-N-D-2L NASA ERTS E-1203-06274-5 01

Figure 20 – Great Kavir, March 1, 1973; false-color composite of ERTS-1 image. EDC-010018.

Figure 21 – Great Kavir, May 12, 1973; false-color composite of ERTS-1 image. EDC-010019.

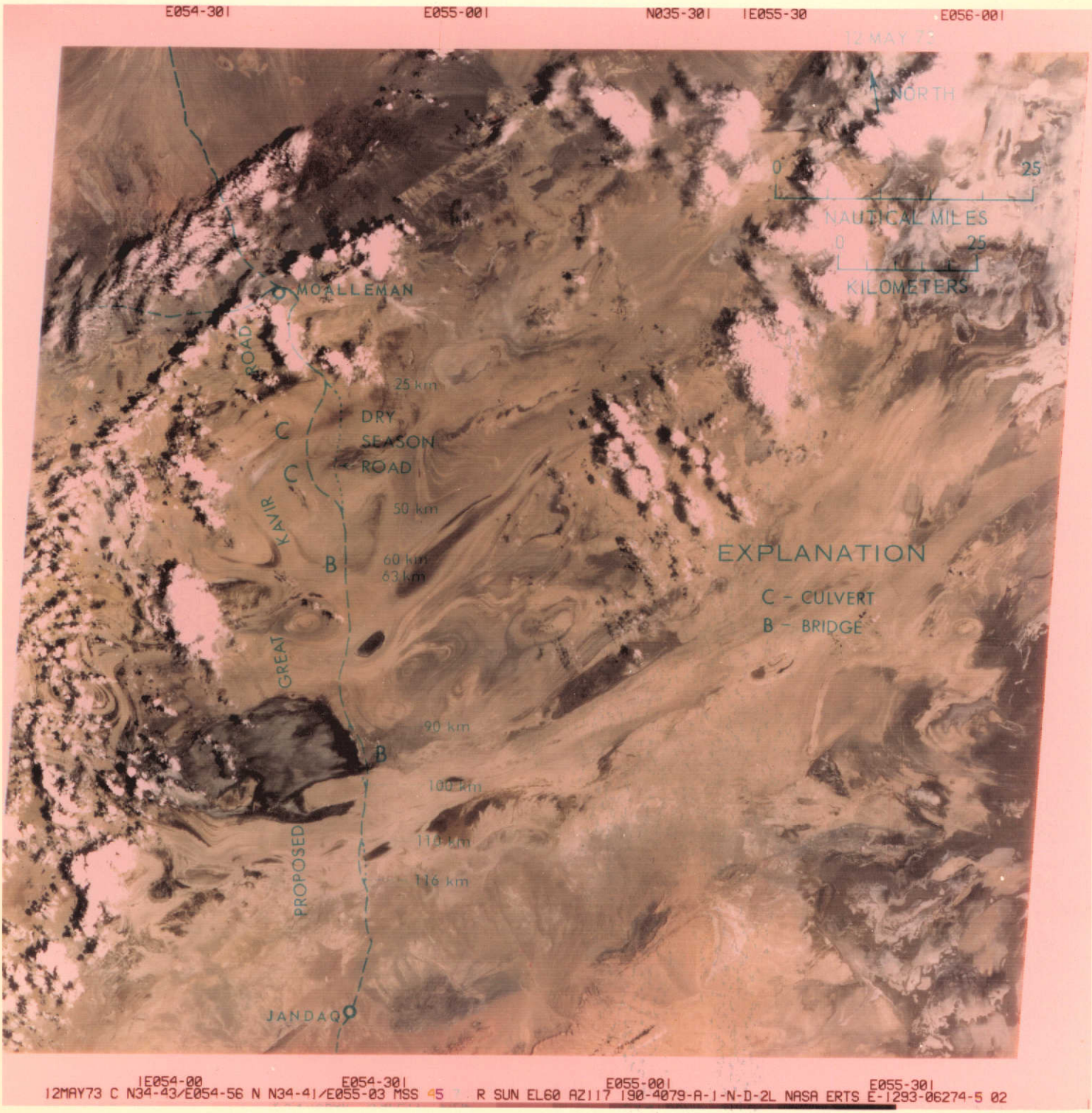
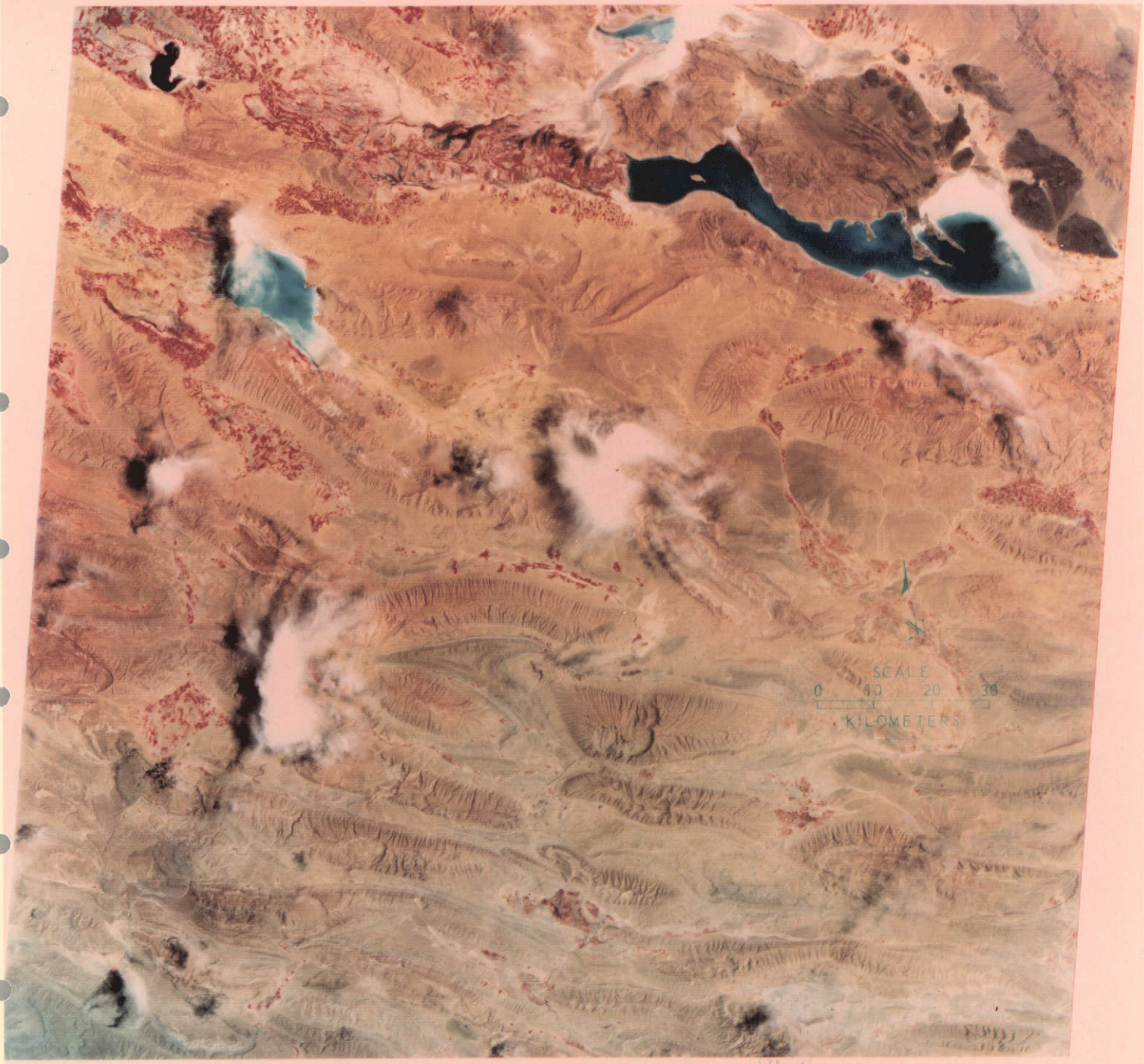


Figure 22 – Shiraz Playa (northwest quadrant) and Neriz Playa (northeast quadrant), May 12, 1973; false-color composite of ERTS-1 image. The small reservoir northwest of Shiraz Playa is due to an impoundment in the Rud-E-Kor, a stream which empties into Neriz Playa through an extensive delta deposit. EDC-010020.



E052-301 E053-001 E053-301
12MAY73 C N29-01/E053-13 N N28-57/E053-22 MSS 4 5 7 R SUN EL61 AZ106 189-4079-A-1-N-D-2L NASA ERTS E-1293-06292-5 02

Figure 23 – Pit in the surficial sediments at Neriz Playa.

Figure 24 –Collecting salt at the west margin of Shiraz Playa.

Figure 25 – Lake fluctuations at Shiraz and Neriz Playas, September 2 and 20, 1972 and December 19, 1972; false-color composites of ERTS-1 images. EDC-010021.

LAKE FLUCTUATIONS AT SHIRAZ AND NERIZ PLAYAS
SEPTEMBER 2, 1972 TO DECEMBER

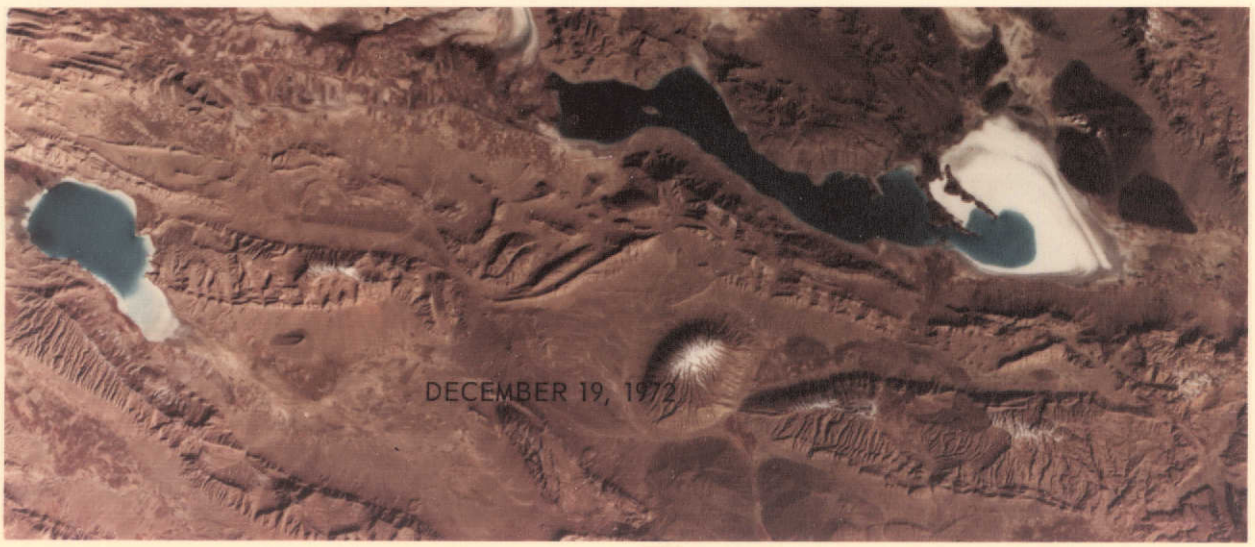


Figure 26 – Lake fluctuations at Shiraz and Neriz Playas, March 1 and 19, 1973, May 12, 1973 and August 28, 1973; false-color composites of ERTS-I images. EDC-010022.

LAKE FLUCTUATIONS AT SHIRAZ AND NERIZ PLAYAS
MARCH 1, 1973 TO AUGUST 28, 1973

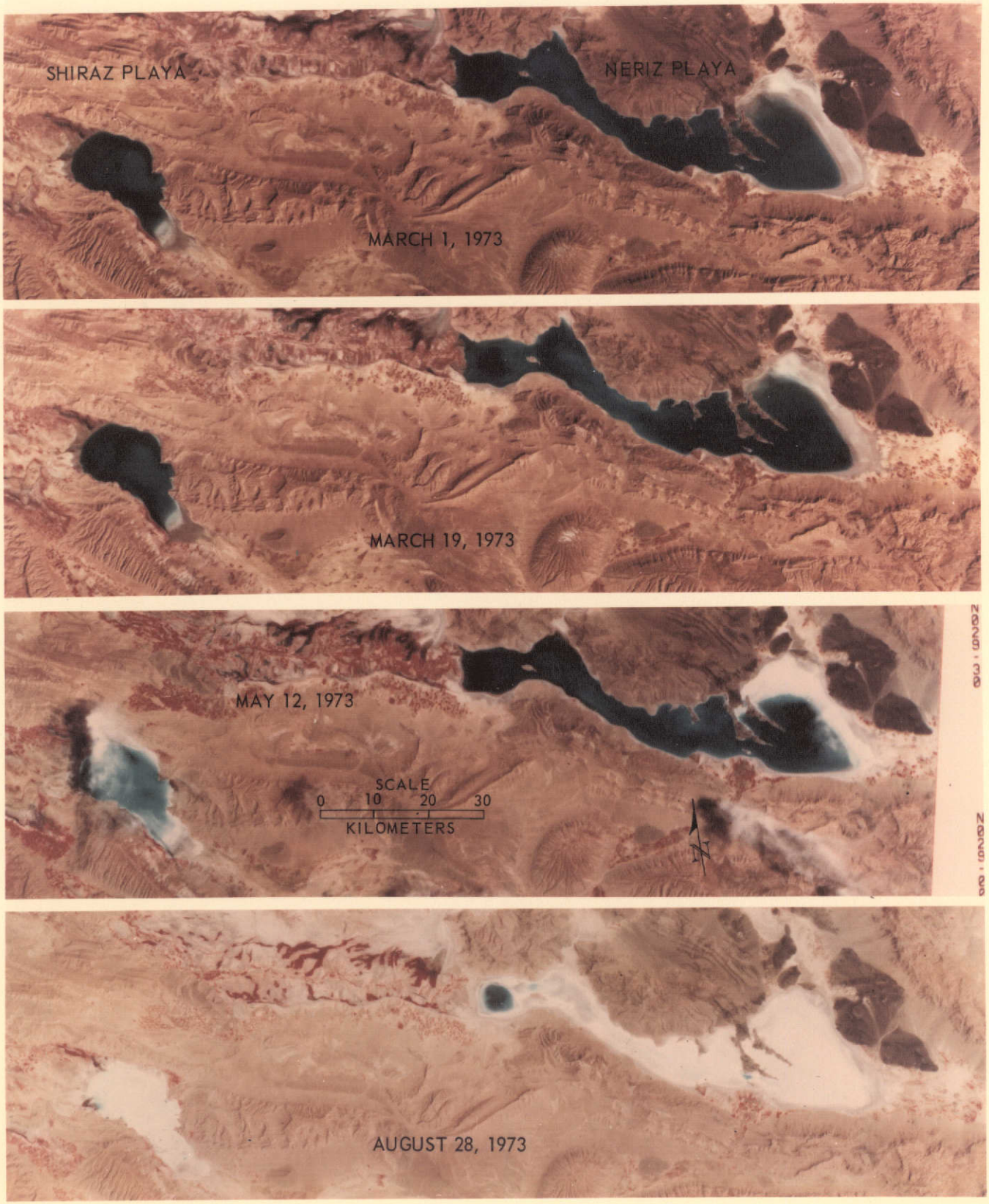
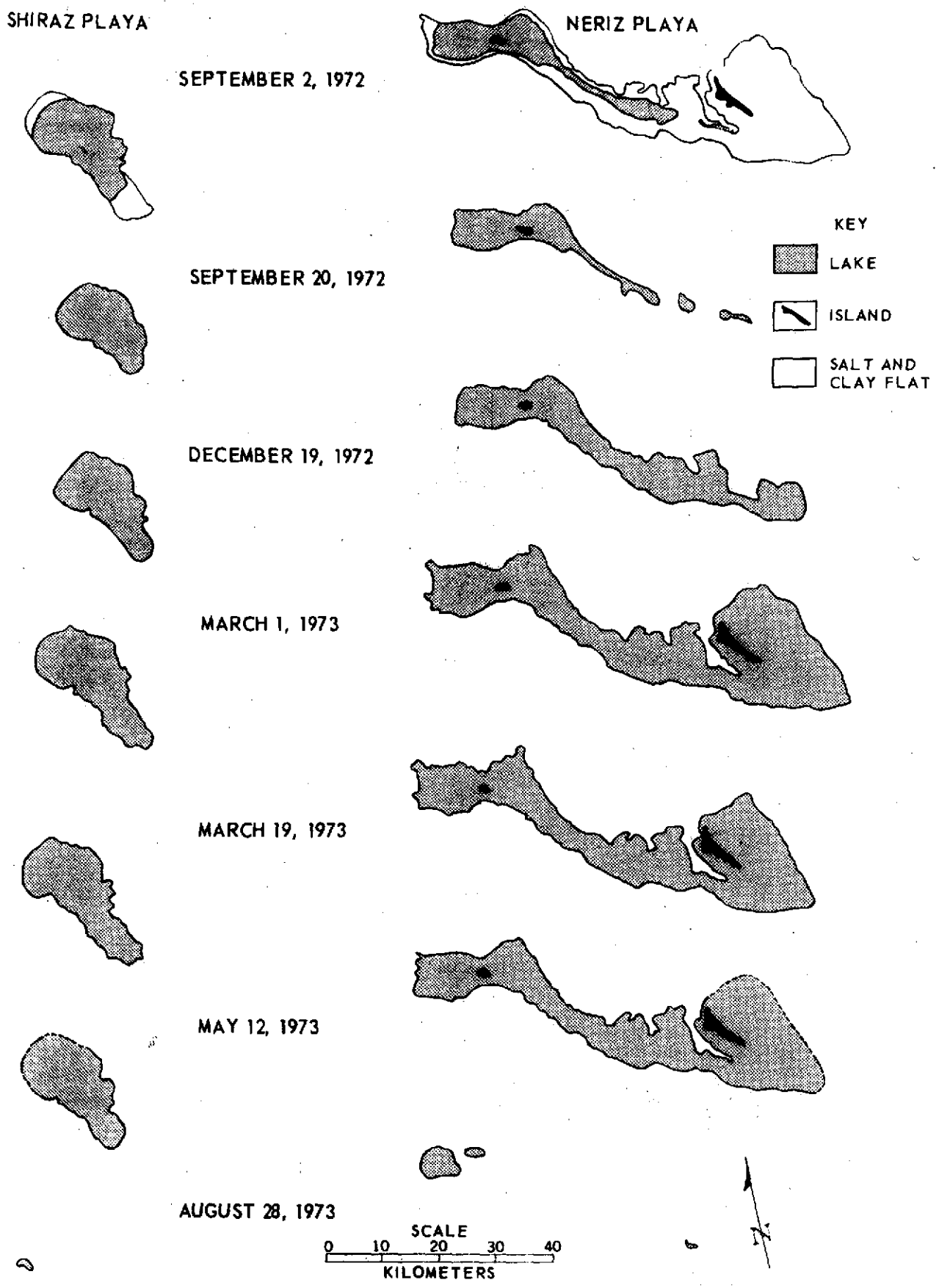


Figure 27 – Lake fluctuations at Shiraz and Neriz Playas from September 2, 1972 to August 28, 1973.

LAKE FLUCTUATIONS AT SHIRAZ AND NERIZ PLAYAS 1972-73



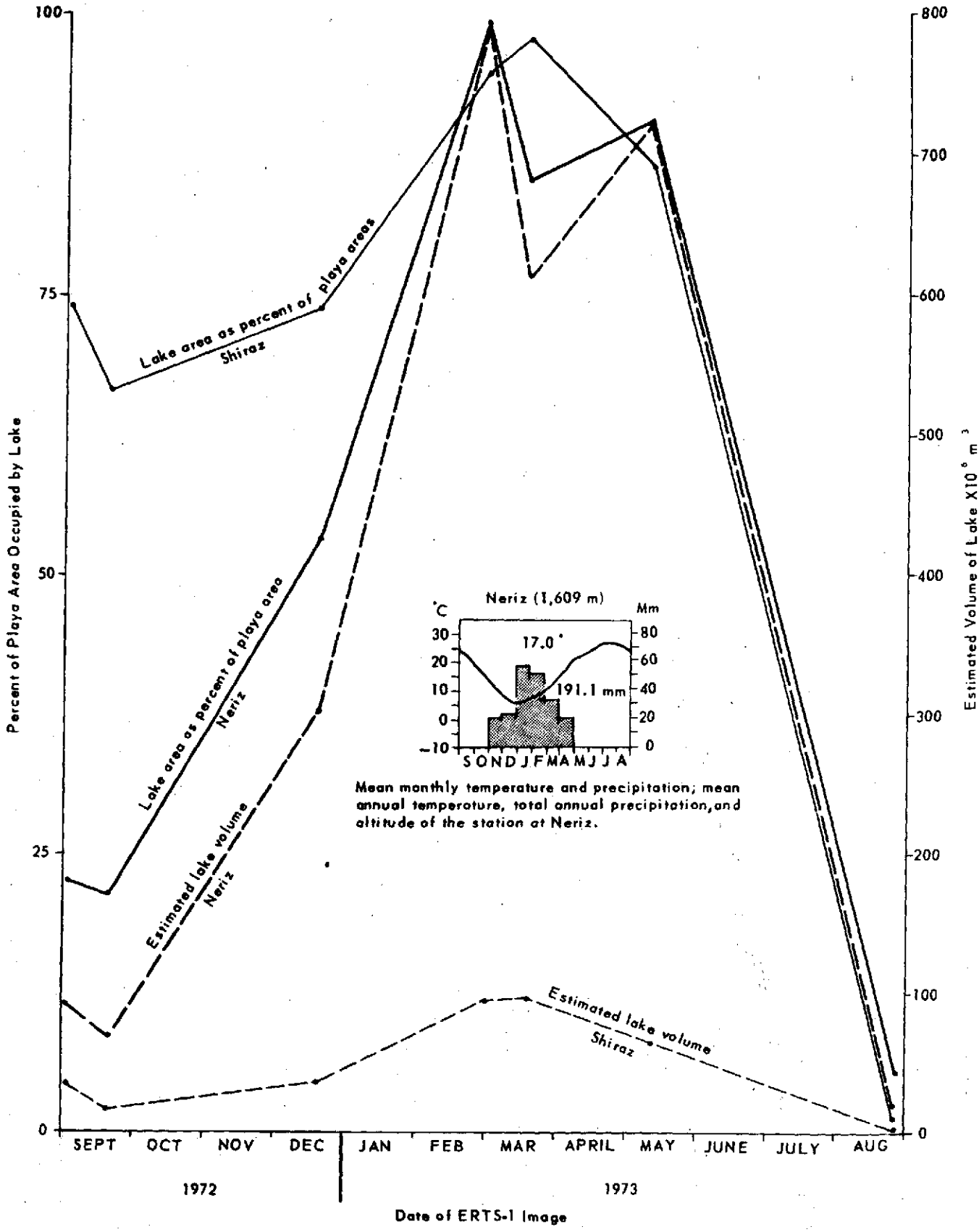


Figure 28 – A comparison of the climatic data from Neriz with the lake areas at Shiraz and Neriz Playas as a percent of the playa areas, and the estimated lake volumes from September 2, 1972 to August 28, 1973.

Table 1.--Hydrologic conditions at Qom Playa from September 4, 1972, to May 14, 1973, as inferred from false-color composites of ERTS-1 images

Identification of ERTS-1 Image*	Extent and Condition of Lake Area	Extent and Condition of Wet Area	Extent and Condition of Salt Crust
Sept. 4, 1972 N34-29, E52-17 8104306382 Figure 3	Lake area is 65 km^2; 3%** Estimated average depth 0.5 m Estimated volume 33×10^6 m^3; clear	Wet area is 391 km^2; 20%** Veneer of wet salt covers wet clay	Salt crust area is 1,504 km^2; 77%** Salt crust is locally moist
Sept. 22, 1972 N34-32, E52-20 8106106381 Figure 7	No lake present; area of previous lake covered with a veneer of wet salt	Wet area is 450 km^2; 23% Wettest area is peripheral to area previously occupied by lake	Salt crust area is 1,510 km^2; 77% Salt crust is dry
Dec. 3, 1972 N34-24, E52-12 8113306391 Figure 7	Lake area is 130 km^2; 7% Estimated average depth 0.5 m Estimated volume 65×10^6 m^3; sediment light	Wet area is 339 km^2; 17% Wettest area is north of lake; local ponding; sediment light	Salt crust area is 1,491 km^2; 76% Salt crust is stained by silt-laden streams from the south
Dec. 21, 1972 N34-37, E52-18 8115106390 Figure 7	Lake area is 342 km^2; 18% Estimated average depth 1.0 m Estimated volume 342×10^6 m^3; heavy sediment	Wet area is 243 km^2; 12% Wet area is almost entirely south of lake; local ponding and heavy sediment	Salt crust area is 1,375 km^2; 70% Salt crust is heavily stained by silt-laden streams from the south
Jan. 8, 1973 N34-34, E52-21 8116906384 Not illustrated	Lake area is 364 km^2; 19% Estimated average depth 1.0 m Estimated volume 364×10^6 m^3; moderate sediment	Wet area is 290 km^2; 15% Wet area is almost entirely south of lake; area obscured by clouds; moderate sediment	Salt crust area is 1,306 km^2; 66% Salt crust is moderately stained by silt-laden streams from the south
May 14, 1973 N34-41, E52-03 8129506391 Figure 7	Lake area is 397 km^2; 21% Estimated average depth 1.0 m Estimated volume 397×10^6 m^3; light sediment	Wet area is 253 km^2; 13% Wet area is almost entirely south of lake; local ponding	Salt crust area is 1,310 km^2; 66% Salt crust is saturated in 2/3 of its area; local ponding; light silt staining

*Date, location, identifier (EROS Data Center identification number), and figure number in this report

**Percent of playa area (1,960 km^2)

Table 2.--Surficial analysis of Qom Playa on September 22, 1972, as inferred from a comparison of regular and computer enhanced false-color composites of ERTS-1 images and from ground investigations

Composite Fig.	Band or ratio	Color	Wet Area	Salt Crust Area
7	7 5 4	Blue Red Yellow	White central and peripheral zones are smooth white salt recently precipitated or washed; blue zones are deeper toned with increasing depth of water; blue annular zone around wet area is ponded water.	Yellowish-white area is salt crust with raised-ridge polygons; scattered white zones are smooth salt crust recently washed; purple-stained salt crust is covered with silt and clay; dark purple areas are two islands; Sargardani Island lies off south shore.
10	5/6 5/7	Blue Red	Darkest central and peripheral zones are smooth white salt recently precipitated or washed; purple zones are wet; pink annular zone around wet area is ponded water.	Magenta area is salt crust with raised-ridge polygons; small scattered violet areas in the northern half are smooth salt crust recently washed; Sargardani Island is outlined off south shore.
11	5/6 4/5 4/6 5/7	Blue Red Yellow Green	Green central and peripheral zones are smooth white salt recently precipitated or washed; blue zones are wet; white to orange annular zone around wet area is ponded water.	Brown area is salt crust with raised-ridge polygons; small scattered green zones are smooth salt crust recently washed; light green areas are the two islands; white-green area at south shore is probably wet smooth salt crust with clay and silt.
12	4/6 5/7 5/6 4/7	Blue Red Yellow Green	Brown central and peripheral zones are smooth white salt recently precipitated or washed; yellow zones are wet; light blue annular zone around wet area is ponded water.	Blue to brown area is salt crust with raised-ridge polygons, dark blue to brown zone is stained by silt and clay; small scattered light brown areas are smooth salt crust recently washed; islands are outlined; bright brown area at south shore is probably wet smooth salt crust.

Table 3.--Hydrologic conditions along critical segments of the dry-season road across the Great Kavir as inferred from ERTS-1 images

Identification of ERTS-1 Image*	Distances in kilometers south from Moalleman			
	25 - 50	60 - 63	90 - 100	110 - 116
Sept. 2, 1972 N34-35, E55-09 8104106265 Figure 16	Moist surface at km 40	Moist surface at km 62	Dry salt crusts	Moist surface at km 113
Sept. 20, 1972 N34-35, E55-12 8105906265 Figure 17	Moist surface at km 40	Moist surface at km 62	Dry salt crusts	Moist surface at km 113
Dec. 19, 1972 N34-35, E55-09 8114906273 Figure 18	Wet surface at km 40; dissolution of salt crusts	Moist surface at km 62	Moist to wet salt crusts; dissolution of salt crusts	Moister surface at km 113
Feb. 11, 1973 N34-35, E55-05 8120306274 Figure 19	Wet surface at km 40; dissolution of salt crusts	Obscured by cloud	Wet soil and salt crusts; dissolution of salt crusts	Obscured by cloud
March 1, 1973 N34-36, E55-01 8122106275 Figure 20	Wet surfaces at km 32 and km 40; dissolution of salt crusts at km 40	Partly obscured by cloud, probably wet	Wet soil and salt crusts; dissolution of salt crusts; standing water	Wet surface at km 113
May 12, 1973 N34-43, E54-56 8129306274 Figure 21	Wet surfaces at km 32 and km 40; dissolution of salt crusts at km 40	Wet surface at km 62	Wet soil and salt crusts; dissolution of salt crusts; standing water	Wet surface at km 113
	Summary	Summary	Summary	Summary
	Alinement to west with culverts probably required over wet areas	Bridge or raised roadbed required	Raised roadbed and bridge required	Alinement to west around wet area

*Date, location, identifier (EROS Data Center identification number), and figure number in this report

Table 4.--Lacustrine fluctuations at Shiraz and Neriz Playas, September 2, 1972, to August 28, 1973, as inferred from ERTS-1 images

Identification of ERTS-1 Image*	Extent of Lake at Shiraz Playa (playa area 247 km^2)	Extent of Southern Lake at Neriz Playa (playa area 797 km^2)
Sept. 2, 1972 N28-49, E53-28 8104106283 Figure 25	Lake area 182 km^2, 73%** Average depth 0.2 m Est. volume 36×10^6 m^3	Lake area 185 km^2, 23%** Average depth 0.5 m (deepest at west end) Est. volume 93×10^6 m^3
Sept. 20, 1972 N28-51, E53-31 8105306203 Figure 25	Lake area 165 km^2, 66% Average depth 0.1 m Est. volume 16×10^6 m^3	Lake area 170 km^2, 21% Average depth 0.4 m (deepest at west end) Est. volume 68×10^6 m^3
Dec. 19, 1972 N28-52, E53-27 8114906291 Figure 25	Lake area 182 km^2, 73% Average depth 0.2 m Est. volume 36×10^6 m^3	Lake area 430 km^2, 53% Average depth 0.7 m (deepest at west end) Est. volume 301×10^6 m^3
March 1, 1973 N28-52, E53-21 8122106293 Figure 26	Lake area 234 km^2, 94% Average depth 0.4 m Est. volume 94×10^6 m^3	Lake area 794 km^2, 99% Average depth 1.0 m (deepest at west end) Est. volume 794×10^6 m^3
March 19, 1973 N28-49, E53-16 8123906294 Figure 26	Lake area 240 km^2, 97% Average depth 0.4 m Est. volume 96×10^6 m^3	Lake area 682 km^2, 85% Average depth 0.9 m (deepest near west end) Est. volume 614×10^6 m^3
May 12, 1973 N29-01, E53-13 8129306292 Figures 22, 26	Lake area 213 km^2, 86% Average depth 0.3 m Est. volume 64×10^6 m^3	Lake area 722 km^2, 90% Average depth 1.0 m (deepest at west end) Est. volume 722×10^6 m^3
Aug. 28, 1973 N28-55, E53-20 8140106280 Figure 26	Lake area 3 km^2, 1% Average depth 0.3 m Est. volume 0.9×10^6 m^3	Lake area 38 km^2, 5% Average depth 0.5 m Est. volume 19×10^6 m^3

*Date, location, identifier (EROS Data Center identification number), and figure number in this report

**Percent of playa area